Green River CO_2 natural analogue, Utah: insights into Fe mobilisation from jarosite fracture mineralisation.

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Outcrop samples of the Jurassic Entrada Sandstone in the Green River area of Utah, USA, have been studied as part of a CO_2 storage natural analogue study (CRIUS consortium). These rocks are locally bleached, the pattern of which is enigmatic but commonly associated with sub-vertical fractures. In some locations these fractures are pathways to recent carbonate travertine deposits. Of key interest is the fate of Fe, whose reduction and mobilisation is implied by the host rock bleaching patterns and which is present in travertine deposits, and CO_2-rich springs and geysers in the area.

Petrographic analysis has revealed a complex and unusual textural and mineralogical assemblage in the fractures. Jarosite ($KFe_3(SO_4)_2(H_2O)_6$) has been identified; its formation is typically associated with oxidative alteration of sulphide minerals and acid mine drainage[1]. Cubic pseudomorphs mostly comprising goethite, centrally concentrated in the fractures and containing rare pyrite relics, suggest pyrite was the primary fracture mineralisation, and may indicate that S-bearing reducing fluids are responsible for the host rock bleaching patterns.

Expansive textures associated with the jarosite suggest that it formed with minimal overburden, and that the oxidative fluids were a near-surface episode. Zones of complete and then partial dissolution of diagenetic carbonates in the host sandsones adjacent to the fractures, associated with Al oxide / hydroxide mineralisation, are consistent with low pH fluids resulting from sulphide oxidation. Gypsum- and calcite-cemented fractures cross-cut the jarosite mineralised textures; these later events relate to current CO_2-rich fluid movements since they can be observed to form part of the feeder system linking directly to travertine deposits at some locations. This paragenesis shows that the same fracture flowpaths have been used by several generations of fluids.

Petrographic observations, together with an experimental study of Fe mobilisation from the Entrada Sandstone, suggest that dissolved Fe in the modern regional CO_2-rich fluids is largely derived from the fracture mineral assemblage, rather than through current alteration and beaching of the host rock.

[1] Bigham, J.M. & Nordstrom, D.K. (2000): Iron and aluminium hydroxysulfates from acid sulfate waters. Reviews in Mineralogy and Geochemistry. 40, 351-403.

Observed Aerosol Effects on Eastern Pacific Stratocumulus Clouds

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Aerosol particles in the marine boundary layer include primary organic and salt particles from sea spray and combustion-derived particles from ships and coastal cities. The Eastern Pacific Emitted Aerosol Cloud Experiment (E-PEACE) 2011 was a targeted aircraft campaign to assess how different particle types nucleate cloud droplets. Particle sources included shipboard smoke-generated particles with 0.05-1 μm diameters (which produced tracks measured by satellite and had drop composition characteristic of organic smoke) and combustion particles from container ships with 0.05-0.2 μm diameters (which were measured in a variety of conditions with droplets containing both organic and sulfate components) [1]. Three central aspects of the collaborative E-PEACE results are: (1) the size and chemical composition of smoke particles compared to cargo ship emissions as well as background marine particles, (2) the characteristics of cloud track formation for smoke and cargo ships, as well as the role of multi-layered low clouds, and (3) the implications of these findings for quantifying aerosol indirect effects. For comparison with the E-PEACE results, the preliminary results of the Stratocumulus Observations of Los-Angeles Emissions Derived Aerosol-Droplets (SOLEDAD) 2012 provided evidence of the cloud-nucleating roles of both marine organic particles and coastal urban pollution, with simultaneous measurements of the effective supersaturations of the clouds in the California coastal region.

[1] L.M. Russell et al. (2013)., Bull. Am. Meteorol. Soc.

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